

S&T Campaign: Materials Research Manufacturing Science Energy Coupled-to-Matter

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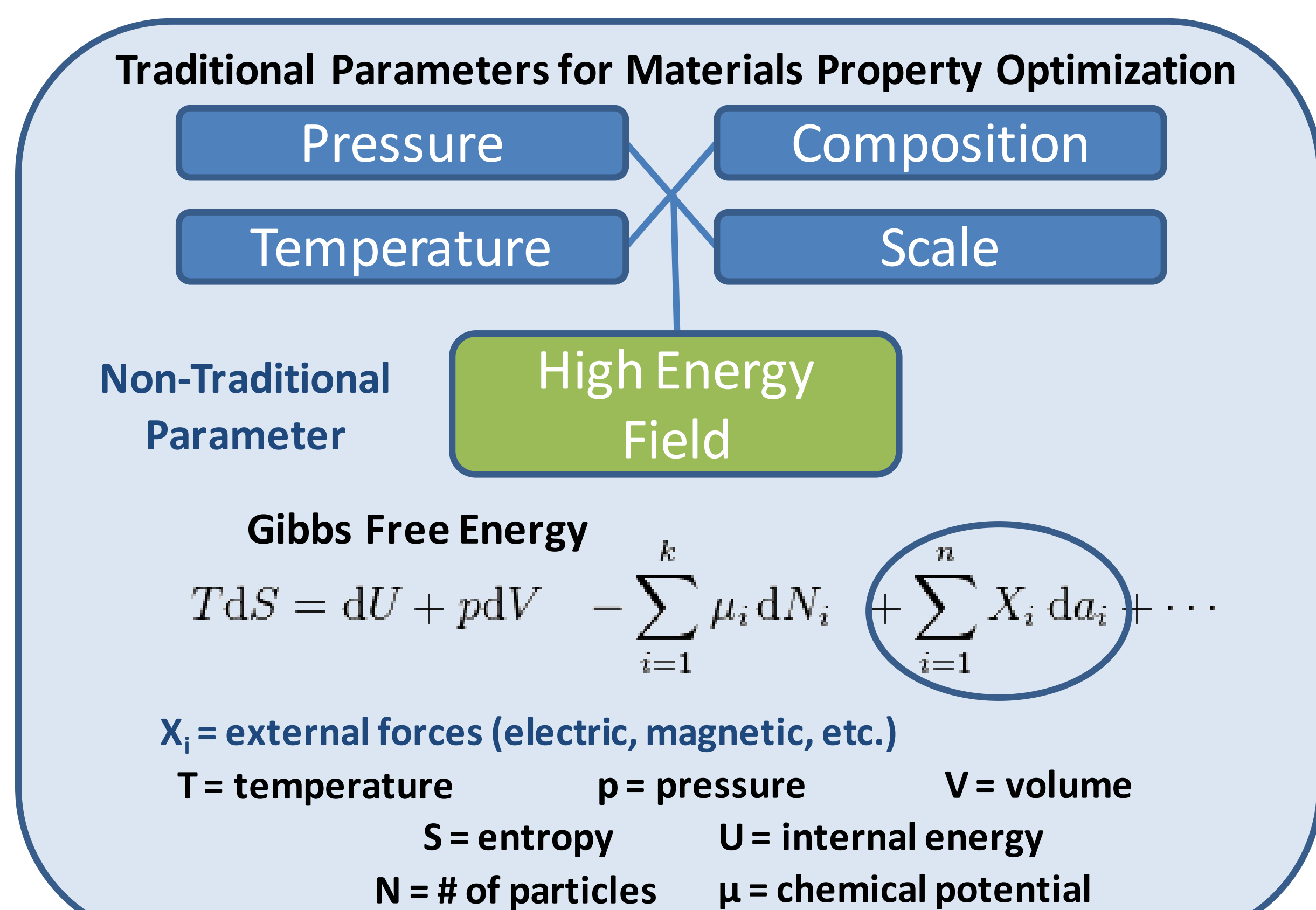
Research Objective

To discover, explore, and exploit interactions between materials and intense energy fields (magnetic, electric, acoustic, etc.), thereby enabling significant property enhancements and unique property combinations, overcoming traditional engineering trade-offs (e.g. strength vs. ductility) and allowing responsive on-demand structure-property modification

- Utilize **physics-based fields** to produce outcomes that are otherwise unattainable, expanding materials-by-design & manufacturing science innovation capabilities for:
 - Novel materials with **tailored microstructures** and **unprecedented properties** (e.g. 1.5-10X property/performance improvements)
 - New **processing & manufacturing** capabilities for rapid materials production
 - Selectively enhanced time-dependent effects via **dynamic stimulation**

Challenges

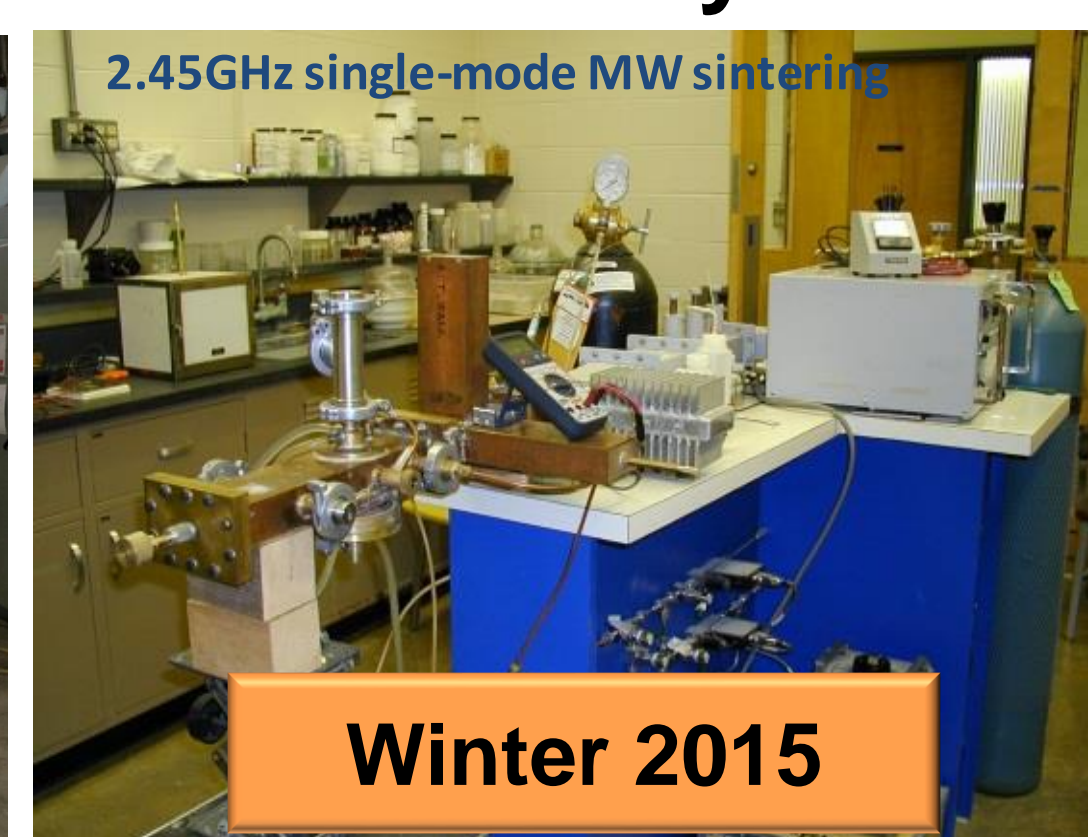
- Developing fundamental understanding of mechanisms that influence field-material interactions
- Identifying phenomena that control applied field manipulation
- Developing approaches to demonstrate enhancement in properties
- Performing numerical modeling/simulation to predict influence of applied fields
- Developing methods of in-situ characterization during high energy field application to materials



Influence of High Energy Fields on Thermodynamics

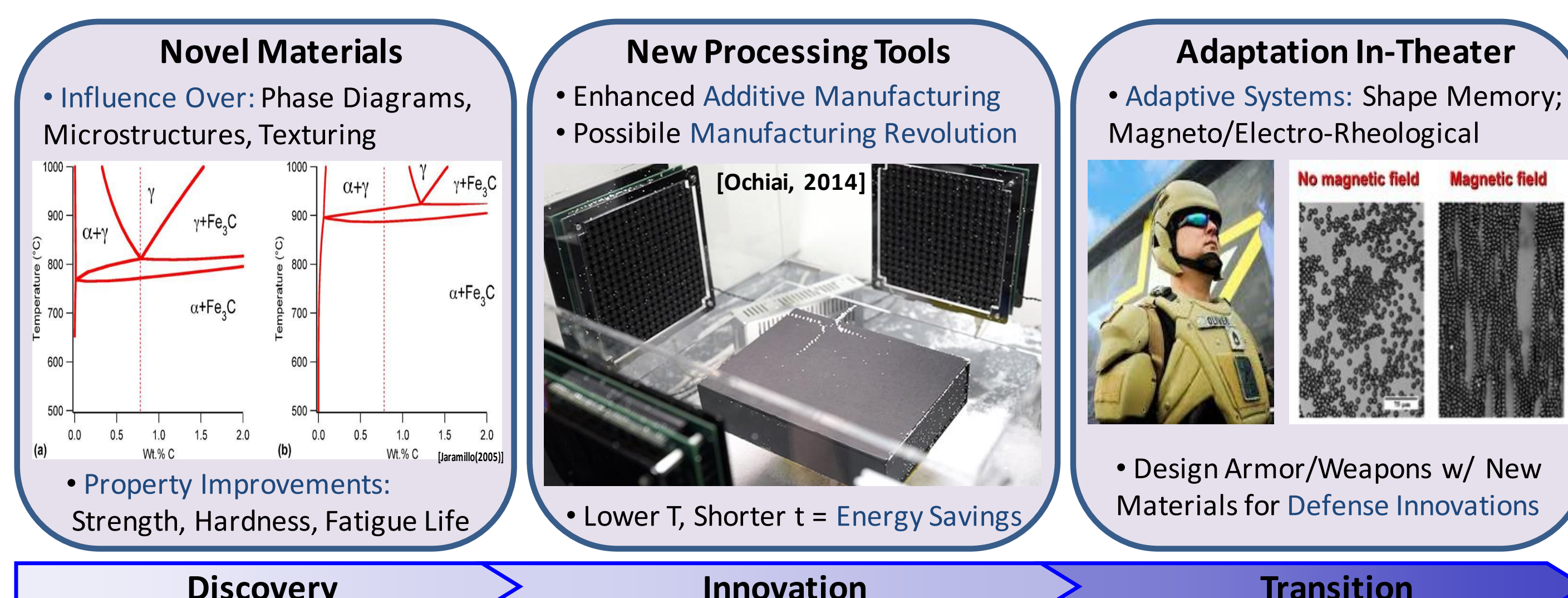
ARL Facilities and Capabilities Available to Support Collaborative Research

- ECM Laboratory under development to include:
 - Physical Property Measurement System (PPMS)
 - Ultrasonic Additive Manufacturing (UAM)
 - Single Mode Microwave Sintering Systems 2.45/5.8 GHz, 2000oC, 5,000 psi pressure
 - Thermomagnetic Processing Systems 9 Tesla, 8" bore, 2200oC, pressure
- ECM modeling & simulation software currently available: Thermo-Calc and COMSOL Multi-Physics



Complementary Expertise / Facilities / Capabilities Sought in Collaboration

- Novel processing capabilities for applying individual or combined high energy fields (electric, magnetic, acoustic, microwave, radiation, microgravity, etc.) to materials
- Insight into fundamental mechanisms & physics behind high energy field-material interactions
- Modeling & simulation expertise and research tools for predicting high energy field-material interactions
- In-situ characterization technologies for accessing and studying behavior of materials in high energy fields



ECM Research Areas for Discovery, Innovation & Transition